ECONOMIC SERIES No. 11

BRITISH MUSEUM (NATURAL HISTORY)

FURNITURE BEETLES

THEIR LIFE-HISTORY
AND
HOW TO CHECK OR PREVENT THE DAMAGE CAUSED BY THE WORM

BY

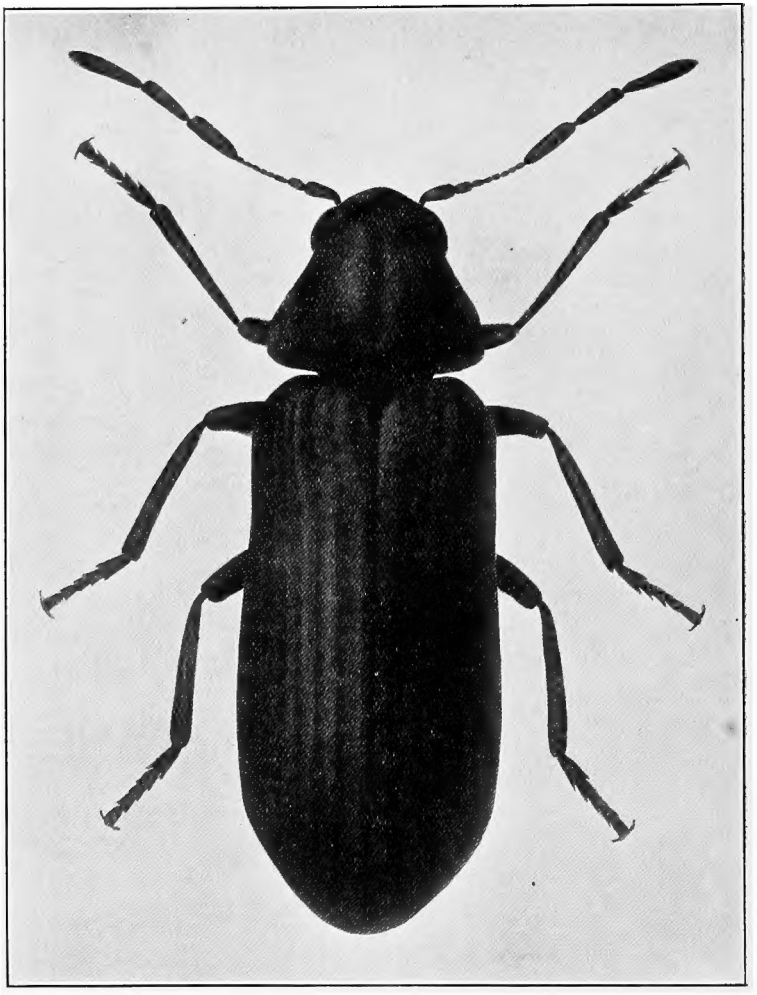
CHARLES J. GAHAN, D.Sc.

KEEPER OF THE DEPARTMENT OF ENTOMOLOGY

WITH ONE PLATE AND FIVE TEXT FIGURES.

LONDON
PRINTED BY ORDER OF THE TRUSTEES
OF THE BRITISH MUSEUM
1920

[PRICE SIXPENCE.]



The Common Furniture Beetle, *Anobium punctatum*, De Geer.
× 25 diameters.

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SOLD AT
THE BRITISH MUSEUM (NATURAL HISTORY), CROMWELL ROAD, S.W. 7.
AND BY
B. QUARITCH, LTD., 11, GRAFTON STREET, NEW BOND STREET, W. 1.
AND DULAU & CO., LTD., 34-36, MARGARET STREET, CAVENDISH SQUARE, W. 1.
1920

LONDON:
PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,
DUKE STREET, STAMFORD STREET, S.E. 1, AND GREAT WINDMILL STREET, W. 1.

FURNITURE BEETLES

I.—GENERAL INTRODUCTION

It is not infrequently the householder's lot to see some valued piece of furniture or some part of the wood-work in the house damaged or destroyed by what is commonly known as *the worm*—little six-legged, white grubs which live inside the wood devouring it and turning it to powder.

These destructive grubs eventually become small beetles. The worm or grub has to the beetle the same relationship that a caterpillar has to the butterfly or moth into which it will turn.

A beetle is, like a butterfly, one of those insects which in the course of their life undergo a complete metamorphosis or change of form. Coming from *an egg* to begin with, it appears at first in the form of a *larva* or grub. The larva feeds actively and continues to grow for a more or less prolonged period, until, when full-fed and full-grown, there comes a resting stage; then it is transformed into a *pupa* or chrysalis, from which, after a further lapse of time, the beetle emerges to appear shortly after in the full development of form and colour which it will retain for the rest of its days.

In its final form a beetle usually has two pairs of wings, but the front wings are quite unlike ordinary insect-wings; they are the hard, scale-like structures which, meeting by their inner edge along the middle line form a sheath or cover over the middle and hinder part of its back. The hind wings or true flying wings of a beetle, when not displayed in flight, are kept folded and hidden for the most part beneath its modified fore-wings, which hence receive the name of *wing-cases* or *elytra*.

There are very many different species of beetles in the world whose larvae live in wood and damage it to a more or less serious extent by feeding on it and forming tunnels or burrows as they eat their way in various directions. Where a great number of

larvae are present, and fresh generations continue to appear, they may in a relatively short period of time reduce the wood almost entirely to a condition of powder or dust, little of the solid tissue being left except a thin outer shell and only so much of it inside as will barely suffice to keep the whole together.

The species which in this country most commonly prove destructive to furniture and to worked wood in general are limited in number to about five, three of which belong to the family of beetles named Anobiidæ, and two to a distinct but not very distantly related family to which the name Lyctidæ is given. One of the five species, *Anobium punctatum*, De Geer (*see* Frontispiece and Fig. 1), is so much more frequently met with than the rest, especially in old furniture, that it may, by way of distinction, be referred to as the common furniture beetle. Although often alluded to in books as "the death-watch beetle" or as one of the death-watch beetles, its claim to that title rests on no satisfactory evidence.

The true "death-watch beetle," which is a member of the same family, is also one of the furniture beetles. It seldom attacks ordinary movable furniture, but is very destructive at times in old houses and other buildings in which oak or chestnut is the wood used in the structure or the fittings. The vast amount of damage caused by its larvæ to the old oak rafters and beams in the roof of Westminster Hall is a notable instance of the kind.

It is in April or May, the time of year when the pairing of the beetles takes place, that their tapping noise * is most often heard. The method by which it is produced has frequently been observed, and is quite simple : the beetle jerks its body forwards seven or eight times in rapid succession, and strikes each time with the lower front part of its head against the surface on which it happens to be standing. It gives the eight taps in slightly less than a second of time; and almost before it stops another of the beetles, if within hearing, will respond by tapping back in the same quick manner. In wood-work or furniture that has been attacked by the death-watch beetles, the worm-holes are large and distinguishable also by the character of *the frass* or powder which falls from them or fills the burrows inside.

The worm-holes which show at the surface of worm-eaten furniture are but rarely made by the worms or larvae, and then

* The name "death-watch" is also applied to the tiny insect known as the book-louse, and more appropriately, the ticking it makes being slower, less loud, longer continued, and altogether more like that of a watch.

more by accident than otherwise. They are mostly drilled by the beetles themselves, in order to make their exit from the wood. The width of each hole may, therefore, be taken as a fairly accurate measure of the width of body of the beetle that made it. Those made by the death-watch beetles have on an average nearly twice the diameter of the holes made by the other species of furniture beetles, and the powder is characterised by the peculiarly rounded plano-convex or bun-shaped form of the pellets or grains of which it is in great part composed. The pellets are the excrement of the larvae.

When the wood of furniture is one of the less hard kinds, and worm-holes of less than a line in diameter appear in it, the common furniture beetle may generally be suspected as the species concerned in their making; but sometimes *Ptilinus pectinicornis*, L. (*see* Fig. 4), a species of a little larger size and more cylindrical form, distinguished according to sex by the comb-like or beautifully branched structure of the antennae or feelers to be seen projecting from its head, turns out to be the author of the damage.

If, however, worm-holes which look like those of the common furniture beetle begin to appear in furniture that is new, or at least not many years old, and made of such wood as oak, ash or walnut, though not of pine-wood, it will then very often be found that the holes had been made by one or other of the two Lyctid species of furniture beetle. The Lyctidae are widely known in America by the name of powder-post beetles. They do not attack the wood of coniferous trees, but are very destructive to wood of various other kinds, especially after it has been seasoned a few years and the sap has become quite dry. They begin always by attacking the sap-wood, which they prefer, and rarely penetrate quite into the heart of the wood. In a remarkably short time they convert almost the whole of the sap-wood into a very fine powder. Of the two species which occur in this country, one, which used to be less common, now appears to be the more widely spread, and to be spreading more and more as time goes on. In recent years several instances have been brought to our notice in which panelling of oak, walnut or sycamore, and furniture made of the same woods or ash, have suffered very serious damage from the larvae of this species. The beetles abound in several timber yards in London, and doubtless in many others throughout the country. In some cases large stacks of wood have been in great part destroyed by them.

There is a great temptation in times of scarcity to use up all the wood available, and the sap-wood, which ordinarily would be, or ought to be, rejected, is occasionally retained in the manufacture of furniture. Where broad panels made of single boards are used, the retention of some part of the sap-wood can scarcely be avoided; and it appears, moreover, that the beauty due to the graining of the wood is often best displayed in that part of it, which is also the part most subject to attack by the beetles. Precaution should in such cases be taken to make sure that the wood, to begin with, is free from all traces of the worm.

Length of the larval period.—From the time that the eggs are laid until the adult beetles make their exit from the wood twelve months at least will elapse, and with some of the species the period may be two or three years or even longer. It follows, therefore, that the larvae may be at work unseen within the wood for quite a long time before the worm-holes appear, which give the first indication of their presence. But it would be a mistake to suppose that "worm-holes" are always a sign of active work going on inside the wood. For not only may they be seen in very old furniture, which the beetles had long since ceased to attack, but occasionally also are to be found in articles of the most modern design, in which no other trace of the little wood-borer is visible. There are "worm-holes," too, which are not the exit-holes made by the beetles, but merely the open ends of long narrow burrows which were in the wood before it was worked up, and had been cut across in its working. Furniture made of mahogany and other imported woods not infrequently show small holes of this kind, the character of which becomes evident when, say, in the leg of a table or chair you run a piece of wire or a long pin into a hole at one side, and it will go straight through and come out at a hole on the opposite side. It is only when the "worm-holes" appear to be newly made, and keep on appearing, with clean fresh powder falling from them or filling them up, that they may be taken as a sure indication that the living insects are still actively at work inside the wood.

Inasmuch as during the longest period of their life the furniture beetles remain hidden in the wood and do not come under direct observation, a complete and detailed knowledge of their life-history is not very easily to be obtained. But with few exceptions, the main facts relating to it have been observed, and a statement of them will be found accompanying the descriptions of the different species which are given in the following section.

II.—DESCRIPTION AND LIFE-HISTORY OF THE SPECIES

The Common Furniture Beetle. *Anobium punctatum*, De Geer (= *striatum* Oliv.). (*See* Frontispiece and Fig. 1, *a*.)

In the month of June, or sometimes a little earlier or later, the beetles of this species, having emerged from the pupae which lie in little cells just below the surface of the wood, bore their way out, and are then to be seen walking, or occasionally flying about the house. They vary in length from about one-tenth to one-fifth

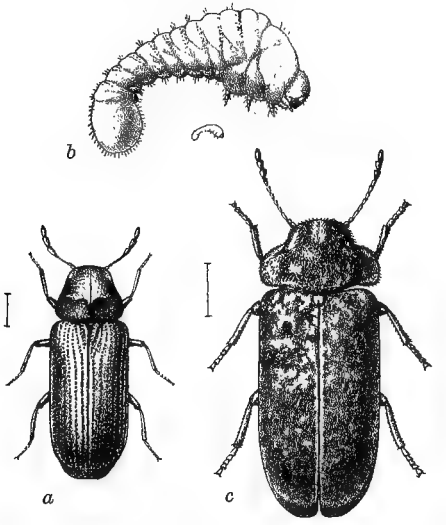

FIG. 1.

a. *Anobium punctatum*, De Geer. *b*. Its larva. *c*. *Xestobium rufovillosum*, De Geer.

of an inch, and are of a reddish brown or darker brown colour, somewhat modified by a fine covering of short yellow-grey hairs. On the wing-cases is a series of narrow longitudinal grooves or striae, marked each with a row of closely-set small pits or punctures. The prothorax, or first body segment, strongly raised in the middle, overlaps the head in front, and, seen sideways, looks like a little bonnet or hood covering it. Another distinctive feature well shown in the figures, is the length and shape of the three last joints of the 11-jointed antennae.

The instinct by which many insects are led at the first sign of danger to draw in the legs and antennae to the sides or beneath the body, and then remain perfectly motionless like bits of inanimate matter is very strongly marked in these little beetles. They are noted for their persistency in "shamming death" while undergoing quite rough treatment. But the stories told of their stoicism at such times are sometimes greatly exaggerated. A puff of tobacco smoke well directed very quickly sets them on their legs again.

The tapping with which they are credited in common with the true death-watch beetles has never been witnessed by the present writer, who has many times kept them under close observation especially during the pairing season, when the tapping should, if at any time, be made.

Pairing begins and goes on freely soon after the beetles have come out from the wood, and a day or so later the females are to be seen in search of suitable places in which to deposit their eggs; or they may return through the exit holes to lay them inside the wood near the entrances to the old burrows. The ovipositor of the female can be extended telescope-fashion to the length of more than half her body, and carries at the end two little appendages which appear to act as feelers. When seeking a place to lay her eggs, the female extends her ovipositor, bends it first to one side then to another, exploring the surface, until it touches upon some slit or crack suitable to receive the eggs. There she deposits them, one or two at a time, sometimes in greater number, according to the length or size of the receptacle, and then continues the search and deposits others until her whole supply is exhausted. She seems to avoid, if possible, laying her eggs on a smooth or exposed surface. The average number of eggs laid by each female is not known, but it is probably less than a score.

The eggs (Fig. 2) are oval, or lemon-shaped, white in colour, and so small that one of them placed on the small letter "o" of diamond type, would not quite cover it. Those represented in the figure, magnified 40 diameters, were laid in a crack in the bottom of a small wooden box, in which some of the beetles were being kept under observation.

The *larvae* hatch out three or four weeks after the eggs are laid, and either begin at once to burrow into the wood or wander about a little at first over its surface. At this time they are very small, and are straight-bodied, instead of having the body strongly

curved as in older larvae; seen through the microscope they show no trace of the peculiar little brown spinules in rows across the back which characterise the latter, and they differ also in having on each side of the front of the head a very minute but quite distinct black spot, where in the older larvae, the small convex, simple eye, scarcely different in colour from the surrounding integument, makes its appearance.

As they gradually grow and increase in size, the burrows they make by biting the wood with their hard sharp jaws and devouring it as they go along, become correspondingly wider, until when the larvae are nearly full-grown and about one-fifth of an inch long,

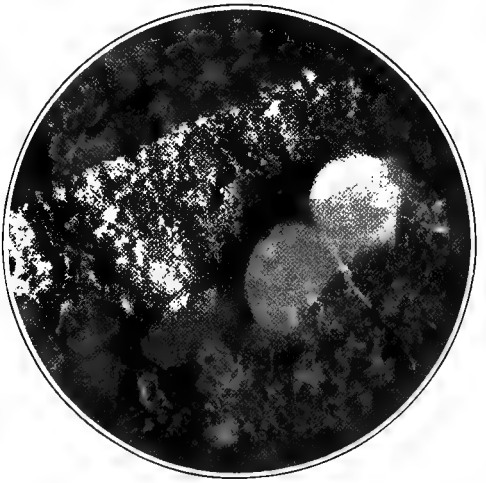

FIG. 2.

EGGS OF *Anobium punctatum*, De Geer, × 40 diameters.

their burrows are almost a twelfth of an inch, or one line, in diameter.

The larvae are almost entirely white in colour, the head being somewhat less white, with the parts around the mouth reddish-brown and the tips of the biting jaws nearly black; the first three body-segments carry each a pair of short 5-jointed legs; and across the more elevated portion of the back of the third and of each of the following seven segments a number of small brown spinules are set in *a double row*. These spinules are not present in newly-hatched larvae, but at what stage they first begin to appear has not been determined. They assist the move-

ments of the larva in the wood by enabling it to get a grip with its body when it presses against the top or sides of the burrow. Their special arrangement is somewhat different in the different species of Anobiid larvae; and their presence is a character by which these may be distinguished from the larvae of the Lyctid beetles, which do not possess them at any stage of life.

The posterior body-segments are somewhat longer and more swollen than those in front, and are curved round to lie beneath them. The spiracles, or apertures for admitting air to the body, are as usual in beetle larvae, nine in number along each side, but are all very small and not easily made out in this species.

When the larvae have burrowed deeply into the wood, the amount of air which reaches them cannot be great, though it must be enough to support their life. The powder left behind them

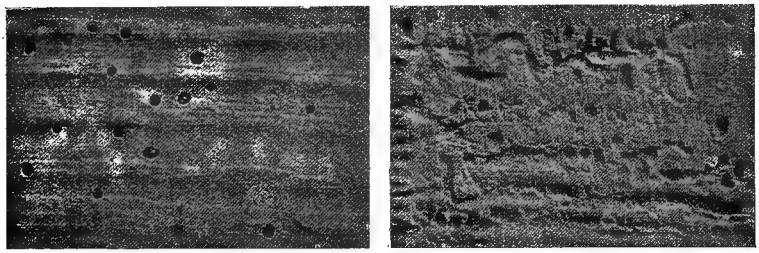

FIG. 3.

a. Worm-holes in deal flooring (nat. size). *b*. Section through the wood.

filling the burrows is generally very closely packed. It consists partly of rejected fragments of the wood, and in part of the undigested material which they excrete in the form of small oval pellets. They shed their skin at intervals in the course of their growth, and when the time for pupation is near, they direct their burrows towards the surface, but stop short before quite reaching it. In a little cell, made by enlarging the burrow near its end, and cementing together fragments of wood to block up the entrance, the larva changes to a *chrysalis* or *pupa* of a white colour and with a rather soft skin. Two or three weeks later the beetle emerges from the pupa, and as soon as it has become hard in body and jaws, bores its way to the outside from the end of the larval burrow.

How long the larva lives from the time of hatching until pupation begins cannot be definitely stated, for it seems to depend

greatly upon the conditions. But the whole life-cycle, from the laying of the eggs until the beetles appear, must take at least a year or almost a year for its completion. According to some authors it is one year, as a rule, in the case of this species when living out of doors in the dead branch of a shrub or tree. We have reason, however, to believe that when living in dry old furniture it generally takes two years, if not more, to complete its whole development from the egg onwards to the perfect insect. Early in March we have found larvae in two or three different stages of development, which could not all have come from eggs laid in the preceding year. They must have belonged to at least two generations, and probably were of three different generations.

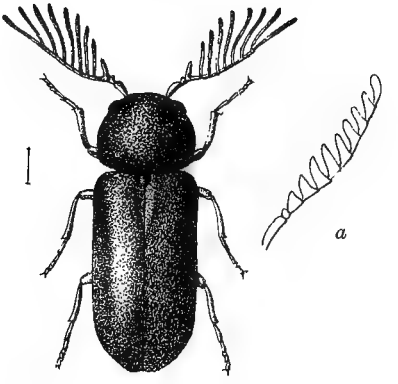

FIG. 4.

Ptilinus pectinicornis, L. male. *a*. Antenna of female.

In the case of the death-watch beetle, and of *Anobium hirtum*, a species which lives in old books, we have had larvae under observation which lived for nearly three years.

The number of generations all living at the same time inside the wood becomes a question of some importance when the application of remedies has to be considered.

The exit holes of the common furniture beetles (see Fig. 3, *a*) vary according to the size of the individual beetles, from about half to three-fourths of a line in diameter. They occur commonly in flooring and rafters of deal and pine-wood, as well as in furniture made of these or the wood of deciduous trees such as oak, beech, alder, willow, and many others.

Those made by *Ptilinus pectinicornis*, usually in wood of the

same kinds, are, on the average, slightly larger. This species does not, however, so frequently attack furniture, although many cases of damage are on record, including one in which a new bedstead is said to have been completely reduced to powder by the larvae in three years. The beetles (Fig. 4) are cylindrical in form and dark brown in colour. Their wing-cases are not punctured in rows nor striate, and their antennae have so characteristic a shape that the species becomes easily recognisable. They appear towards the end of May and in June, and their life-history, so far as it is known, is on the whole very similar to that of the common furniture beetle. The larvae, in their later stages at least, are distinguishable by the presence of groups of very minute brown spinules on the sides of certain of the body-segments, as well as scattered irregularly, forming indefinite bands, across the back. No eyes are visible; but observations on the newly hatched larvae appear not to have been made, nor have the eggs been described.

The Death-watch Beetle. *Xestobium rufovillosum*, De Geer (= *tessellatum* Oliv.). (*See* Fig. 1, *c*.)

The beetles of this species begin to make their appearance outside the wood they infest about a month earlier than the common furniture beetle, April and May being the months in which they are most abundant and their tapping most vigorous. It appears, however, that they do not, like the common furniture beetles, bore their way out very soon after their emergence from the pupae, but having emerged one year, remain within the pupal cells through the winter until the following spring, and then make their exit from the wood. Their exit holes vary from about one-eighth to one-sixth of an inch in diameter.

The beetles are from one-fourth to one-third of an inch in length, and are dark brown in colour, spotted or banded irregularly with thick patches of short yellow-grey hairs. Seen through a lens, the upper surface, where bare, being densely covered with punctures, has an appearance like shagreen. The prothorax, convex above, slopes down towards the broadly flanged sides, the latter suggesting what one of the first writers to describe the death-watch beetle, was mistakenly led to call its ears.

It seems hardly possible to doubt that these beetles possess the sense of hearing; but where the organs of that sense are lodged is another question. It is generally believed that they reside in the antennae.

The tapping to which we have already referred, made in the

pairing season, is of the nature of a sexual call, and in some cases may be repeated over and over again for quite a long time. A female of this species, captured when it had just come out of the wood at the end of March 1917, was placed in a small box where it continued to live for ten weeks, and at almost any moment throughout the whole of that time was ready to respond by tapping her head against the bottom or sides of the box, to a sound made by tapping at the same rate with a pencil on anything within a few yards of her prison.

In the normal course pairing takes place shortly after they have made their exit from the pupal cells, and the beetles probably die a few weeks later, the female in the meantime having laid her eggs. *The eggs* are white, and oval in form like those of *Anobium punctatum*, but nearly twice as large. *The larvae* when newly hatched are correspondingly larger than those of that species in the same early stage, but otherwise are very similar in character, except, however, that instead of having only one small, black spot for an eye on each side of the head they have two small black spots. When nearly full grown, the larvae are from about one-third of an inch to little short of half an inch in length, with the body strongly curved behind, and the more elevated portion of the back of each segment from the 3rd to the 9th made rough by a number of small brown spinules set in a broad band; there are spinules also, but not more than a few rows deep, on the back of the 10th segment, none or only a few on the 11th, and a number on the sides and ventral surface of the swollen and rounded 12th or end segment of the body. In other respects there is little to distinguish them from larvae of the common furniture beetle. But their life is probably a year or so longer, for the whole life-cycle in this species seems to take about three years for its completion. Observations in regard to this are, however, difficult, and those made have been few and far between. It is possible that the normal period for the full development of the beetle from the egg up to the final stage may be, as some anthorities believe, only one year, but there is no recorded instance in support of that belief, whereas the larvae are known in more than one case to have lived for a period of nearly, if not quite, three years.

The pupae are soft and white, and the pupal stage is said to last two or three weeks, but as to what time of the year it usually begins there appears to be no definite record. A half-grown larva is stated to have been found in August, and at the same time full

grown larvae and *a pupa*. It seems probable, therefore, that in the case of the death-watch beetle, pupation takes place in the late summer or in autumn, the beetles after emergence remaining in the pupal cells until the following spring. The beetles may be found in-doors in old houses in which oak or chestnut has been used in the structural work or in the panelling of the rooms. Sometimes the larvae burrow in old oak bookcases and other solid pieces of furniture, and we have seen specimens of the beetles that had been taken from old books. Out-of-doors they are to be found in old stumps and dead branches of oak, chestnut, willow, beech, hawthorn and possibly of some other trees as well. Hitherto there has been no record of their attacking the wood of coniferous trees, but quite recently a piece of Scot's pine-wood from an old city church was found completely riddled with their holes; from which it appears that pine-wood when it is very old and has lost all its resinous matter is no longer free from their attack.

The Powder-post Beetles. *Lyctus brunneus*, Steph. and *Lyctus linearis*, Goeze (*see* Fig. 5).

These beetles are little if anything larger than the common furniture beetles, but are relatively longer and narrower in form, and not so convex. There is, however, considerable variation in size, some individuals being only one-eighth of an inch, and others more than one-fifth of an inch in length. They are dark brown in colour, with the wing-cases reddish brown and somewhat glossy. The two last joints of the antennae are longer and much stouter than the others, and form a club-like ending. The tarsi, or feet, are 5-jointed and slender, but the first joint is very small and inconspicuous, and the last one, bearing the claws, longer than all the other joints together.

The two species look very much alike, but in *Lyctus brunneus* the prothorax is wider in front than behind, and has a shallow depression along the middle, whereas in *L. linearis* it is more parallel-sided, and has rather a deep pit, elongate-elliptical in form, along the middle. In the latter species also the decumbent hairs on the wing-cases are disposed in longitudinal rows, while in the first species they are spread in a more confused manner.

Both species are widely distributed over the world, and in this country *Lyctus brunneus* now appears to be by far the more common of the two, though it was at one time considered to be a rarity.

The life-history of *linearis* is better known in all its stages than than of *brunneus*, but the differences are so slight that the history of one will probably serve for both. It is on the whole very similar to that of the common furniture beetle, but with differences in regard to time of appearance, the shape of the eggs, and the structure of the larvae. The beetles come out earlier, usually in May, but sometimes not until the middle of June. Pairing follows, and within a day or two after, the eggs are laid by the females. In the case of *Lyctus linearis* the female with her very long ovipositor is said to lay them in slits, cracks and crevices of

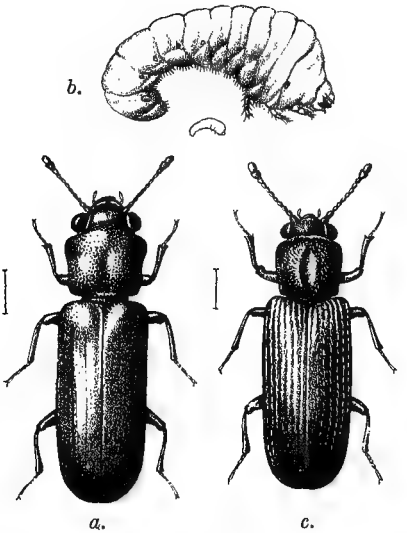

FIG. 5.

a. Lyctus brunneus, Steph. *b.* Its larva. *c. Lyctus linearis*, Goeze.

the wood just as the female of *Anobium* does; but in a recent paper it is stated of *Lyctus planicollis*, an American species, that the eggs are always laid in the pores of the wood, and that each female deposits them in several pores, two or more eggs being inserted near together deep in each pore. This is perhaps what happens also in the case of *Lyctus brunneus*, for we have watched females of this species with their ovipositors well extended, groping about for a place to lay their eggs, but have been unable afterwards to find the eggs, which most likely were hidden away in the pores of the wood.

The eggs are described as being cylindrical in form with rounded ends, white in colour and somewhat shiny, each about 0.8mm., or one-thirtieth of an inch, in length, and not more than one-third of the length in diameter.

The *larvae* hatch out in two or three weeks, and when they have reached a fair size, look at first sight very like those of *Anobium*, but examined under a strong lens, are seen to differ as follows:—The forepart of the body is relatively thicker, and the head more deeply sunk into it and less turned down in front. On the head two short 4-jointed antennae can be made out, whereas in *Anobium* larvae, the antennae are only 2-jointed, and so minute as to be scarcely visible, even under the microscope. The body is without spinules, and of the nine spiracular apertures along each side, the hindmost pair are nearly four times as wide as the others, and can much more easily be seen. In the legs, only three joints are clearly distinguishable; and the front legs are stouter than either the middle or hind pair.

The burrows made by the larvae follow the direction of the fibres in the wood, and are usually more or less parallel, not branching off in various directions as is frequently the case with the burrows of the *Anobium* larvae. Towards the end of March, or somewhat later, in the year following that in which the eggs were laid, the larvae are nearly full grown, and then direct their burrows towards the surface, stopping short as a rule before reaching it; but they sometimes make an opening to the outside and throw out some of the powder. They go back a little way into the burrow to undergo pupation. The pupal stage lasts about a month or a little less; and so the whole life-cycle is generally completed within the space of one year.

The exit holes made by the beetles are similar to those of the common furniture beetle; but the powder is much finer which fills the holes and the burrows.

The wood of pine and other coniferous trees is not known to be attacked by these beetles, but most of the hard woods, especially those with large pores, like oak, ash and hickory, suffer damage from them. Sapwood is the part that most attracts them, and unless treated beforehand with a preservative, this part should not be used in making furniture, nor should it be retained in any wood used for building purposes where strength and lasting qualities have to be depended upon. It is stated that in America, destruction of wood effected by Lyctid beetles once brought about a serious disaster to a railway train.

III.—METHODS OF PREVENTION AND CONTROL

As the furniture beetles all possess wings it is possible for them to fly into the house at the open doors or windows, but far more often they are introduced as larvae in some infested piece of wood or furniture. Once in the house, they may when the time comes, lay their eggs on any unprotected wood whether previously attacked or not. When two pieces of wood are in direct and close contact, the larvae can and very often do burrow from the one into the other, but except when newly hatched or very young, they have the greatest difficulty in walking or in moving at all upon the open surface and never travel in that way from one piece of wood to another.

Fresh damage has its source in the eggs laid by the female beetles, and as the eggs are laid generally in May or June, sometimes a little later, special attention should be given to the furniture at that time of year.

Its treatment at intervals with paraffin oil or turpentine, applied more particularly to the joints and all rough and unpolished parts of the wood should be sufficient to protect it from the egg-laying of the beetles, and thus make it immune from a first attack.

In order to destroy the grubs in wood or furniture already infested and beginning to show worm-holes, the same treatment, if continued over a sufficiently long period, might in the end prove successful. For quicker action other liquids than paraffin oil or turpentine would have to be substituted, or some other method of treatment adopted.

The method best to use depends upon the circumstances of each particular case, and regard must be had not only to the facilities for its application, but also to any ill effects on the wood or furniture which might be likely to arise from the treatment. Were it not for considerations of this kind, there would be little difficulty in dealing with the pest, and in most cases Dean Swift's suggestion might be acted upon, for he was certainly right when in reference to the "wood-worm" he said, that "a kettle of scalding hot water injected, infallibly cures the timber affected."

Unfortunately, the Dean's drastic method, although a perfectly sound one in principle, and always fatal to the worm, can seldom

be applied without some risk of grave consequences to the furniture as well.

1. **Treatment by heat,** wherever it can safely be applied, is undoubtedly one of the quickest and most effective methods of destroying the worm in worm-eaten wood or furniture. The heat need only be sufficient to raise the wood in its deeper parts to a temperature of about 55° C. (= 131° F.), and is generally best applied in the form of dry heat. Unless the wood were more than a few inches in depth, this temperature in the interior would be attained by subjecting it for an hour or two to a heat not exceeding that of boiling water or steam, 100° C. (= 212° F.). Articles of a conveniently small size may be heated in a gas oven, the temperature of which can be regulated so as not to exceed the required amount. Small flat articles could be sufficiently heated over a hot-water cistern. In the case of large articles, a hot-air jacket or hot-air chamber may be necessary.

2. **Fumigation with a gas or vapour.**—A gas can penetrate more deeply than a liquid into wood, and is, therefore, more likely to reach and destroy the larvae in the deeper parts. Fumigation, however, depends greatly for its success on the degree to which the chamber or other receptacle in which it is carried out can be made airtight. Specially constructed chambers or large cylinders, from which the air can be pumped out and replaced with the fumigating gas or vapour are of course best; but in their absence use can be made of such means as are available, a large tightly-fitting box, a glass case, a tank, a small spare room, etc.

The most effective gas to use for the purpose, *hydrocyanic acid gas*, is at the same time the most dangerous. It is a deadly poison, and should never be used for the treatment of furniture except by experts who are familiar with the danger and will take all the necessary precaution in carrying out the measures required.

The heavy vapour given off from *carbon disulphide* on exposure to the air is nearly as effective, and on the whole is less dangerous; but it takes fire at a not very high temperature, and if mixed with air is liable to explode with violence. It must therefore be used only with very great caution. The method is the same as in the case of benzene vapour mentioned below, but the dishes into which the liquid is poured should rest on a bracket or shelf fitted near the top of the fumigating box or other receptacle instead of being placed at the bottom.

Sulphur dioxide, the gas or vapour generated by burning sulphur, has certain disadvantages owing to its tarnishing and

bleaching properties; but in cases where these are not a source of objection, it may be used with very good effect for fumigating worm-eaten furniture or wood fixtures of a room.

It is obtainable compressed into liquid form in steel cylinders, and by means of suitable appliances may be forced under its own pressure into worm-eaten wood.

Another method by which it may be applied is to dissolve camphor in the liquid, and paint the solution over the wood to be treated. The camphor soon crystallizes out and forms a temporary crust which prevents the escape of the gas outwards and causes it to penetrate the wood. This method has been tried on an experimental scale and found successful in destroying the worm.

The *vapour of benzene*, if proper precautions are taken against the danger from fire or lights, is probably the best and safest gas to use for the fumigation of wood-carvings and small gilt or ornamented articles of furniture. The article to be treated is placed in a well-made, tight-fitting box or case, and the benzene poured into saucers or shallow dishes, is placed at the bottom of the box, which should then be closed, made as airtight as possible, and left for some time. When the benzene has all evaporated more should be poured into the dishes.

Old books infested with the "book-worm," which is usually the larva of the common furniture beetle or of some other Anobiid beetle, may be successfully treated in this way. Vapour of benzene is very penetrating, is an effective insecticide, and has no deteriorating effect on paper or on delicate woodwork of any kind.

Carbon tetrachloride, another very volatile liquid, which is not highly inflammable like benzene, and for that reason safer, may be used instead for household purposes in the treatment of furniture. Its vapour being very heavy, the liquid should, like carbon disulphide, be placed in the upper part of the fumigating chamber when used for fumigation.

3. **Treatment by the application of a liquid.**—When other methods are not easily available or, for one reason or another, are objectionable, treatment by the direct application of a liquid, either as a wash or by injection may be adopted, and for this purpose *benzene*, *carbon tetrachloride* or *terebene* can be used. The liquid may be applied with a brush to the unvarnished or unpolished parts of the worm-eaten article, and injected with a syringe into the worm holes wherever they appear on the surface.

Naphthalene is readily dissolved in carbon tetrachloride, and

the solution may be used instead of the tetrachloride by itself. The naphthalene remains as a deposit in the wood for a long time after the liquid has evaporated, and serves as a protection to it, though it adds to its inflammability, and may on that account be objectionable.

One of the oldest and most effective methods of treating worm-eaten wood is to inject it with a solution of corrosive sublimate (mercuric chloride) in methylated spirits. But, owing to its extremely poisonous nature, mercuric chloride is a very dangerous substance to use for the purpose, though with reasonable care it might be used on a small scale and in special cases. To be really effective in destroying the worm, it would need to be used in the proportion at least of five parts to one hundred of the liquid. As a protection to wood against the worm a one or two per cent. solution would probably suffice. In 1864, a commission appointed by the Science and Art Department to inquire, recommended fumigation with benzene vapour as the most suitable method for destroying the worm in wood-carvings and other kinds of woodwork preserved in the South Kensington Museum; and as a future protection from the attacks of the worm, they advised painting with a solution of mercuric chloride in methylated spirits or in parchment size, according to the nature of the surface to be treated, the proportion in either case to be sixty grains of the chloride to each pint of the liquid used, or somewhat less than a one per cent. solution. In the process known as the Kyanizing of wood, it is saturated under pressure, or injected, with a one to three per cent. solution of corrosive sublimate in order to protect it from the decay due to either fungi or insects. The disease of timber called *dry-rot* is brought about by the attack of fungi, and is not to be confounded with the powdered state which results from the action of the worm. Dry-rot and the worm are, however, very often found closely associated in the same wood, the damp, ill-ventilated conditions which conduce to the one being also favourable to the development of the other.

In cases where discoloration of the wood does not matter, as in outbuildings, and in the structural wood of dwelling-houses, it may be treated with carbolic acid, creosote, or one of the other tar-oil derivatives, as a protection from the worm as well as from other sources of decay.

Best time to apply treatment to worm-eaten furniture.—From what has been said of the life-history of the beetles, it will be understood that the larvae or worms approach the surface

when the time for pupation is near, and leave only a small thickness for the beetle to bore through in order to get outside. But in the case of the common furniture beetle and of the death-watch beetle, larvae of a later generation and in an earlier stage of development may at the same time be in the deeper parts of the wood.

If liquids be applied at the time of pupation or just before, the larvae near the surface of the wood may be reached and killed, while those in the deeper parts would probably be untouched; but twelve months later these larvae, in their turn, would come near the surface to pupate, and then another application of the liquid should be made. The eggs are more resistant than the larvae or beetles to the action of a liquid or a gas, and the pupae probably are so, too; and treatment with a liquid or gas is best, perhaps, applied either before pupation takes place or after the young larvae have hatched out—that is, in the case of the common furniture beetle, about the middle of May and the end of July or beginning of August. With the other species, earlier. It would be better still to give a treatment at both periods—one, say, in May, to be followed by another in July or August. Heat, if sufficient to raise the temperature in the interior of the wood to 130° F., will kill all the insect life inside, and may be applied at any time, although heat also would have a better chance of reaching the larvae if applied at the time when they are nearest the surface.

Whatever method be adopted, there is always the possibility that some of the eggs or larvae may for the time being escape, but if the treatment be repeated and given at the best period each year for a few years in succession, any one of the methods mentioned should in the end prove successful in completely eradicating the worm.

LONDON:
PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,
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